

BENEFITS OF RISK-BASED ANALYSES IN FLOODPLAIN MANAGEMENT A FEMA PERSPECTIVE

by

Michael K. Buckley, P.E.¹ and Richard A. Wild²

INTRODUCTION

Throughout our history, Americans have settled next to rivers, streams, and other waterways because of the advantages the waterways offer in transportation, commerce, energy, water supply, soil fertility, and waste disposal. These benefits notwithstanding, the American attraction to settling along waterways does have its drawbacks. Floods have caused considerable loss of life and property, and they have disrupted more families, businesses, and communities nationwide than all other natural hazards combined. As we move into the 21st Century, we, as a nation, find ourselves at a crossroads in our use of floodplain areas. We may choose to use these floodprone lands for the primary purpose of economic development or we may take action to balance economic considerations with longer-term environmental and safety concerns for all citizens.

The Federal Emergency Management Agency (FEMA) has a vision for an effective way to balance the economic, environmental, and safety concerns. That vision is embodied in FEMA's "Partnership for a Safer Future." Under this vision, the United States' emergency management system will be built and maintained through a partnership of local, State, and Federal agencies; voluntary organizations; business and industry; and private citizens. These partners will focus on saving lives and property and reducing the effects of disasters regardless of their cause.

To guide its leadership role in this national emergency management partnership, FEMA adopted two mission-related goals:

1. Protect lives and prevent loss of property from all hazards; and
2. Reduce human suffering and enhance recovery after a disaster event.

FEMA plans to achieve the first goal through mitigation and preparedness initiatives, and plans to achieve the second goal through response and recovery initiatives.

To address the natural hazard posed by flooding, mitigation, preparedness, and response and recovery initiatives and activities can all be grouped under one two-word summary: Floodplain Management. This paper discusses FEMA's view of the future of floodplain management in the United States, the

¹ Director, Hazard Identification & Risk Assessment Division, FEMA

² Operations Manager, Michael Baker Jr., Inc.

role the U.S. Army Corps of Engineers' risk-based analysis approach plays in the assessment of flood-control, and the benefits risk-based analyses may provide in enhancing the decision-making processes involved in wise floodplain management. This paper also provides an overview of FEMA's Disaster-Resistant Communities initiative.

FEMA VIEW OF FLOODPLAIN MANAGEMENT

FEMA defines "floodplain management" as a decision-making process that aims at achieving the wise use of our Nation's floodplains. Through wise floodplain management, we can reduce the loss of life, disruption, and damage caused by floods and preserve and restore the natural resources and functions of floodplains. To achieve the goals of floodplain management, Americans must adopt an approach that takes full advantage of all methods available to reduce vulnerabilities to damage while protecting and enhancing the natural resources and functions of the floodplain. Wise floodplain management would be achieved through

- Avoiding the risks posed by the floodplain;
- Minimizing the impacts of those risks when they cannot be avoided;
- Mitigating the impacts of damages when they do occur; and
- Accomplishing the first three while protecting and enhancing the natural environment.

CURRENT APPLICATION OF RISK-BASED APPROACH

If a levee meets certain requirements, FEMA credits the levee with providing protection from the flood having a 1-percent chance of being exceeded (base flood) on an NFIP map. These requirements are cited in Section 65.12 of the NFIP regulations. One of those requirements is that the levee have at least 3 feet of freeboard (the difference between the top of the levee and the base flood elevation). The freeboard requirement is, essentially, a safety factor used to account for, among other things, the uncertainties associated with the hydrologic and hydraulic analyses used to develop the base flood elevation.

Recognizing the variability in the uncertainties associated with hydrologic and hydraulic analyses, FEMA allows for exceptions to the freeboard requirement. In such cases, FEMA requires an assessment of those uncertainties. The U.S. Army Corps of Engineers (USACE) risk-based analysis provides a comprehensive assessment for considering such exceptions.

Deferring to the USACE expertise in the design and construction of flood-control structures, FEMA accepts certification from the USACE that a levee will provide base flood protection. With the advent of the risk-based approach, the language used in such certifications changed, causing some confusion. FEMA, giving guidance from the NFIP perspective, worked with the USACE to clarify "allowable exceptions" in terms of the risk-based approach. After investigating several applications of the approach, FEMA and USACE agreed that a 95-percent reliability level should be used as

guidance in certifying a levee with less than the required freeboard as providing base flood protection.

OTHER BENEFITS OF RISK-BASED ANALYSES IN FLOODPLAIN MANAGEMENT

FEMA sees the risk-based analysis approach extending beyond cost-benefit analyses for flood-control structures and becoming a useful floodplain management tool. Risk-based analyses can be used to establish floodplain management criteria and to measure the relative progress being made in reducing flood risks within a community. Communities can measure their own progress in reducing risk by applying the risk-based approach as storm water management and floodplain management practices are put in place. The difficulties associated with decision making when contemplating permitting requirements can be reduced significantly when the reliability of design criteria can be quantified. The standard “safety-factor” approach to such decision-making would change to a more risk-based approach.

The uncertainties associated with hydrologic and hydraulic analyses are recognized in the mapping and floodplain management efforts of the National Flood Insurance Program (NFIP); however, these uncertainties have not been quantified specifically in those efforts. Studies performed for FEMA in support of the development of NFIP maps range in scope from approximate analyses to determine approximate floodplain boundaries to detailed analyses using long periods of stream gage records, detailed topographic information, and model calibration from historic recorded flood events.

The reliability of the flood hazard information presented on an NFIP maps depends on the volume of data available to analyze a particular flooding source and the accuracy of those data. That is, a flood discharge estimate derived from a lengthy stream gage record generally is considered to be more reliable than an estimate derived from regression equations developed for a large region consisting of sparse streamflow data. Floodplain managers feel more comfortable allowing development up to a floodplain boundary developed using topographic maps with a 2-foot contour interval than a floodplain boundary developed using topographic maps with a 10-foot contour interval.

The reliability of the national floodplain mapping effort has been a continuous topic of discussion within FEMA, within the engineering community, and among floodplain managers since the inception of the NFIP. Most recently, the Technical Mapping Advisory Council has taken up the issue. Concerns have been expressed regarding the reliability of flood hazard information depicted on NFIP maps when the maps are used for management purposes without an understanding of the limits on accuracy imposed by the underlying amount and quality of data. Because they may not be familiar with those underlying uncertainties, map users/interpreters may mistakenly equate the precision depicted on the NFIP map with a higher degree of accuracy than is warranted.

Many communities, taking these reliability considerations into account, have implemented ordinances to create “buffers” between the flood hazard information available and the flood risk that may be present. These buffers have been defined by requiring the elevation of structures a certain amount above the base flood elevation depicted on the NFIP map and/or by restricting development within a certain distance from the floodplain boundary shown on the NFIP map. In practice, these buffers are

consistent within a community and do not address the possibility that the reliability of the flood hazard information varies within the area covered by the NFIP map for the community.

Steps toward acknowledging the variability in the reliability of flood hazard information have been taken. These steps are demonstrated in several communities that require, for example, varying setback distances that depend on the magnitude of the base flood discharge. The risk-based approach allows the local floodplain manager to extend such attempts to the site-specific level. The approach provides a measurement of reliability on which floodplain managers can make confident decisions in their efforts to balance between the flood risk and the burden placed on the property owners who are compelled to protect themselves.

Having defined the reliability of flood hazard estimates, floodplain managers and property owners can make more informed decisions regarding balancing the costs of further study against the regulatory burdens placed on the property owner. Floodplain managers, working with the property owners, may decide that obtaining more detailed flood hazard information and performing more sophisticated analyses may be warranted if estimates are 40 percent reliable; however, they may decide such efforts are not warranted if estimates are 5 percent reliable.

The risk-based approach yields valuable information regarding future capital investments and/or plans to implement storm water management practices. Risk is the unit used to measure progress toward reducing hazards. Determining both the level of risk a community presently faces and the reliability of that determination will illuminate the more prudent direction to take in furthering hazard reduction efforts. If the reliability of the estimate of the present risk is relatively small, the benefits of various mitigation strategies may be obscured. It may be unwise to choose between different mitigation strategies when the benefit estimates fall within the uncertainty associated with estimate of the present risk. The prudent course in such situations may be to expend the effort necessary to increase the reliability of the present risk estimate.

FEMA has undertaken an initiative to create disaster-resistant communities. (This initiative is discussed in detail later in this paper.) Risk—or, more to the point, lack of risk—is the measure of “resistance.” Disaster-resistant communities strive to reduce risks associated with all disasters, natural and technological. They accomplish this by avoiding hazardous situations where possible, mitigating hazards where they cannot be avoided, and continually improving their understanding of the hazards specific to the community. This is consistent with the concept of wise floodplain management cited earlier in this paper. A risk-based approach will be used to track and score the level of disaster “resistance” in a community.

The notion of risk and its subtleties will be a central theme of FEMA’s Disaster-Resistant Communities initiative. The dialogue created by the initiative will broaden the views of officials charged with ensuring safe communities. As an example, consider the floodplain manager faced with the situation described below.

Five streams, each of which drains a relatively small drainage basin (5 square miles), traverse the community. Historically, major flooding in the community has resulted from small, intense

thunderstorms centered over one drainage basin. Although large floods have occurred on all five streams, the largest events are isolated on one stream or another. Two or more streams rarely experience large floods at the same time. Detailed flood hazard information for all five streams is presented on the effective NFIP map for the community. The flood hazard information indicates the flood frequency-magnitude relationship is essentially the same for each stream, and the reliability of the estimates is high.

The community's floodplain management goal is to ensure protection up to the base flood. A risk-based analysis for each stream indicates requiring that a structure be elevated 1.2 feet above the published base flood elevation will provide the desired level of protection, while allowing for complete development of floodplain areas that are not designated as being in the regulatory floodway.

If the anticipated development occurs, at the 1.2-foot elevation requirement, the community can expect flood damage with a frequency of once in a 20-year period (5-percent-annual-chance of occurrence). Thus, although an individual structure may enjoy the acceptable level of risk, the community as a whole does not.

Such a situation might cause confusion among those wishing to develop in the floodplain. A careful investigation and discussion of the risks associated with the individual structure versus the community as a whole should clarify the subtleties in defining risk and place the community's interest in safety into the proper perspective. As the Disaster-Resistant Communities initiative progresses, such discussions will become more common.

OVERVIEW OF DISASTER-RESISTANT COMMUNITIES INITIATIVE

Over the next 3 to 4 years, FEMA plans to encourage the establishment of disaster-resistant communities and to promote safer, more economically sound neighborhoods nationwide. To accomplish this major undertaking, FEMA will work with community, county, and State officials; private industry; the insurance sector, mortgage lenders, the real estate industry, homebuilding associations, and others. FEMA plans to accomplish this by focusing on the following areas of activity:

- Establish a Pre-Disaster Mitigation Fund. This fund will provide financial incentives for high risk communities to undertake mitigation efforts to protect their infrastructure and buildings before disaster events occur.
- Implement a Public/Private Partnership for Emergency Management. FEMA is exploring partnering opportunities with private-sector businesses for identifying disaster risks to communities, developing operating procedures for response activities, planning (short- and long-term), and executing training and exercise programs.
- Overhaul FEMA Public Assistance Programs. FEMA is planning to dramatically streamline its Public Assistance Program procedures and thereby expedite a community's recovery after a disaster.

In addition to these new Agency initiatives, FEMA will encourage the concept of disaster-resistant communities by holding a series of town hall meetings in high-risk areas throughout the United States. The intent of these FEMA-led meetings is to focus public attention on mitigation and community responsibility.

FEMA also plans to promote the Disaster-Resistant Communities initiative by working with the private and public entities cited above to create model communities in high-risk areas. FEMA plans to select four communities that are committed to protecting their citizens, businesses, and infrastructure from the catastrophic effects of disaster events. Each community will address the hazard to which it is most vulnerable. The experiences of these communities will be used to begin the development of transferable models to the rest of the country.

CONCLUSION

In summary, the loss of life, disruption, and damage caused by floods can be reduced and the natural resources and functions of floodplains can be preserved and restored through wise floodplain management. To achieve the goals of floodplain management, Americans must adopt an approach that takes full advantage of all available methods to reduce vulnerabilities to damage while protecting and enhancing the natural resources and functions of the floodplain.

The USACE risk-based analysis approach has proven to be a useful tool in assessing the flood protection capabilities of levees. This approach provides a comprehensive assessment for considering exceptions to FEMA's levee freeboard requirement. However, FEMA sees the risk-based analysis approach extending beyond cost-benefit analyses for flood-control structures and becoming a useful floodplain management tool. Risk-based analyses can be used to establish floodplain management criteria and to measure the relative progress being made in reducing flood risks within a community. Communities can measure their own progress in reducing risk by applying the risk-based approach as storm water management and floodplain management practices are put in place.

The risk-based approach yields valuable information regarding future capital investments and/or plans to implement storm water management practices. Risk is the unit used to measure progress toward reducing hazards. Determining both the level of risk a community presently faces and the reliability of that determination will illuminate the more prudent direction to take in furthering hazard reduction efforts. Such efforts are a primary focus of the ongoing FEMA initiative to establish disaster-resistant communities.

A careful investigation and discussion of the risks associated with individual properties and structures versus the community as a whole should clarify the subtleties in defining risk and place the community's interest in safety into the proper perspective. As the Disaster-Resistant Communities initiative progresses, such discussions will become more common.